Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
	)	
Promoting More Efficient Use of Spectrum	)	ET Docket No. 10-237
Through Dynamic Spectrum Use Technologies	)	

REPLY COMMENTS OF THE PUBLIC INTEREST SPECTRUM COALITION

On behalf of the Public Interest Spectrum Coalition ("PISC")[1], we are pleased to submit these reply comments in response to the Commission's Notice of Inquiry (the "*Notice*") on "Promoting More Efficient Use of Spectrum Through Dynamic Spectrum Use Technologies."[2]

I. Introduction and Summary

As indicated in the initial comments filed by PISC in this proceeding,[3] PISC supports the Commission's initiation of this inquiry as the first step toward fulfilling two recommendations in the National Broadband Plan "to accelerate the development of opportunistic use technologies and to expand access to additional spectrum."[4] The comments filed to date evidence widespread agreement that dynamic spectrum access (DSA) technologies have tremendous potential to promote greater spectrum access, capacity, and efficiency in both licensed and unlicensed bands.

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[1] For purposes of these Comments, PISC includes the organizations Benton Foundation, Free Press, Media Access Project, New America Foundation, and Public Knowledge.

[2] In the Matter of Promoting More Efficient Use of Spectrum Through Dynamic Spectrum Use Technologies, ET Docket No. 10-237, *Notice of Inquiry*, 25 FCC Rcd 16632 (2010) ("*Notice*").

[3] *See* Comments of the Public Interest Spectrum Coalition, ET Docket No. 10-237 (filed Feb. 28, 2011) ("PISC Comments"). Unless otherwise specified, all comments cited herein are initial comments filed in this docket on February 28, 2011.

[4] *Connecting America: The National Broadband Plan*, Recommendation 5.13, at p. 96 (2010).

There is a strong consensus among the comments filed in favor of building on the TV white spaces geolocation database in particular as a means to enable the productive use of unused or underutilized spectrum, based on band-by-band conditions that would ensure no harmful interference to primary licensees. The combination of a transparent, real-time database and spectrum sensing is noted in several comments as a particularly powerful means to protect primary users while making unused spectrum capacity available for flexible, shared use. PISC concurs with other comments suggesting that certain underutilized bands that are spectrally proximate to existing unlicensed bands make particularly promising candidates for consideration as capacity to open for DSA, even if only in certain areas of the country, subject to band-by-band conditions. Finally, PISC addresses the concerns expressed in comments filed by a number of industry associations and individual companies, suggesting that involuntary and/or uncoordinated access to unused spectrum capacity in licensed bands where some of these companies operate would cause severe interference and generally be counterproductive. While PISC agrees that CMRS bands are among the most intensively and efficiently used – and generate enormous economic and social value – it is also important to make a distinction between licensed spectrum that is being used to serve the public interest and licensed spectrum that lies fallow.

II. Extending the TV White Spaces Database to Include Additional Underutilized Bands is a Feasible and Beneficial Means to Facilitate Use of Existing DSA Technologies

Some commenters object to non-voluntary, co-channel sharing of available capacity with their own licensed operations. Yet, there is broad consensus on the feasibility and potential benefits of expanding on the geolocation database technique that will soon govern access to unlicensed TV band channels by placing additional "white space" spectrum in such databases.

Use of these other white spaces would be made subject to band-by-band conditions that avoid harmful interference to primary licensees.

With respect to the question of non-voluntary sharing, AT&T, for example, asserts repeatedly that dynamic spectrum use technologies "are wholly inappropriate for introduction to the licensed mobile bands, except where closely coordinated and controlled by the incumbent licensee."[5] Nonetheless, AT&T states that "properly configured cognitive radios and spectrum sensing devices may have the potential to make more efficient use of underutilized Federal spectrum bands in the areas and at the times when Federal users are not occupying them."[6] Similarly, Verizon Wireless observes that "certain bands may only be used during certain times of day or at certain locations," yet if they cannot be cleared for exclusive reallocation to commercial wireless service, "[d]ynamic spectrum access technologies could make the rest of the spectrum in these bands available for alternative uses, including commercial wireless services."[7]

Expanding the geolocation database that will be pioneered on the unlicensed portions of the TV band also addresses the concern, raised by at least one commenter, that opportunistic access to an unassigned, unused, or underutilized band of spectrum could encumber the band vis-à-vis a future auction or deployment by a licensee. For example, CTIA, commenting on the *Notice*'s suggestion that dynamic spectrum access devices could be allowed to operate in FCC-held spectrum and required to vacate if the band is re-auctioned, opines that the *Notice* "does not explore the process whereby . . . [the DSA] devices would tune away from the successfully auctioned spectrum."[8] Both the geolocation database technique and cognitive radio sensing each

[5] Comments of AT&T, Inc. at i.
[6] *Id.* at 18.
[7] Comments of Verizon Wireless at 19.
[8] Comments of CTIA at 15.

independently include the capability to deny a device permission to use a particular frequency over a particular geographic area or time span. A real-time database could do that instantaneously, as could a signal beacon and/or software update sent to a cognitive policy radio that relied on sensing alone.[9] The TV white space band rules presume multi-band, frequency-hopping radios that automatically move to a different channel if one channel is no longer available. The one caveat is that to avoid economic loss or surprise to consumers, the Commission could decide not to certify DSA devices that rely solely or too heavily on one or two frequency bands. Although the TV white spaces database presumes frequency-agile devices, rules requiring that devices can default to other bands could avoid any concern that "stranded" or "legacy" devices or infrastructure would limit the Commission's ability to reallocate a band, or a primary licensee's ability to buildout or change its operations in a manner inconsistent with shared access. The Department of Commerce Spectrum Advisory Committee (CSMAC) made similar recommendations in its most recent report on unlicensed spectrum.[10]

More generally, PISC agrees with Google's observation that among the central public interest benefits of unlicensed access to TV band white spaces is that such access provides a platform for "a number of enabling technologies that could provide viable starting points for implementing dynamic spectrum use in other bands. One such technology is a real-time database containing information about frequency utilization for any given geographic location, time period, and spectrum band where dynamic access is permitted."[11] Likewise, in its comments, Microsoft correctly points out that "spectrum databases are evolving from simple lookup tables to services providing primary and secondary users the ability to negotiate spectrum access and usage rights in

[9] *See* Comments of Shared Spectrum Company at 15-18.
[10] Commerce Spectrum Management Advisory Committee, Unlicensed Uses Subcommittee Report, at 12 (adopted Jan. 11, 2011).
[11] Comments of Google, Inc. at 10.

real time (*e.g.*, accounting for the cost of interference, power limits, geolocation and mobility, prioritization, and duration)."[12]

PISC also agrees strongly with the views of several commenters, particularly xG Technology, Inc., that "a combination of real time databases and distributed cognitive sensing (with detect and avoid capabilities) should provide primary users sufficient protections while making unused spectrum capacity available for flexible use."[13] xG Technology makes the important point that the combination of cognitive radios and real time spectrum databases can not only protect primary or adjacent channel licensees, but also greatly enhance overall spectrum efficiency and functionality compared to today's more static and hub-and-spoke wireless networks:

> In summary, the Company sees significant advantages to enhancing cognitive radios with real time spectrum databases. While the databases alone will tell the radios what frequencies, power limits, etc. the radios *can* use, cognitive capabilities in the radios (at the edge of the network) can tell them what frequencies and power they *should* use in order to minimize interference (with primary and secondary users) and maximize total user and network throughput.[14]

Moreover, PISC concurs with xG Technology's view that as the TV white spaces database is implemented – and geolocation database techniques prove to be reliable – the Commission should avoid "a one size fits all approach to its dynamic spectrum access policies and service rules."[15] As the Wireless Internet Service Providers Association (WISPA) similarly asserts, rural areas in particular will benefit from more flexible and dynamic governance techniques that would permit variable power limits and antenna height limitations in rural, urban and exurban areas.[16]

Google makes a similar point, observing that "because the TV white spaces rules provide for competing database administrators, offer unbounded opportunities for device manufacturers, and do

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[12] Comments of Microsoft Corporation at 1-2.
[13] Comments of xG Technology, Inc. at 12; *see also* Comments of Motorola at 22; Comments of Google at 10-11.
[14] Comments of xG Technology, Inc. at 13 (emphases in original). The company is a DSA developer that has already successfully deployed two cognitive cellular mobile radio test networks on the unlicensed 900 MHz band, with potential use by the U.S. Army.
[15] *Id.* at 2.
[16] Comments of WISPA at 4.

not mandate particular technology solutions, they serve as a model for the flexible, market-driven approach that the Commission should follow in this proceeding."[17] PISC agrees that the TV white spaces database approach can go beyond playing the role of automated gatekeeper and instead can accommodate a powerful combination of technical and business model flexibility with a very granular view of the spectrum environment on a band-by-area basis. As Google correctly states, the TV white spaces database will be a "model of transparency" that should be expanded to encompass other underutilized and potentially usable bands:

> [T]he Commission should use [the information it currently collects and more] to make available a general database that allows any user with any level of sophistication to determine for a specific geographic location whether particular frequencies are assigned for commercial or non-commercial use and, if so, a point of contact; whether facilities have been constructed; transmitter locations and equipment types; and, importantly, spectrum occupancy data relevant to determining the extent of the entity's spectrum usage.[18]

Public Knowledge, in its separate comments, makes the important observation that the development of the TV white spaces database also provides a platform to enable more widespread and efficient secondary market leasing of unused spectrum capacity.[19] Despite the Commission's approval of private commons rules in 2004, no one has sought approval for devices to implement dynamic spectrum leasing. However, as a technical paper filed by Public Knowledge demonstrates, using the TV white spaces database as a flexible and low-cost platform, innovators will be able to offer licensees the ability to participate in real-time dynamic spectrum auctions for leased access to their spectrum, particularly if the Commission amends certain rules to better streamline the micro-leasing process.[20]

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[17] Comments of Google at 3.
[18] *Id.* at 6-7.
[19] Comments of Public Knowledge at 2-4; *see also* Comments of Google at 10 ("Real-time databases also would be a key component in implementing dynamic spectrum auctions.").
[20] *Id.* at 4 and Appendix: Ian Kash, Rohan Murty, and David C. Parkes, "Enabling Spectrum Sharing in Secondary Market Auctions," Harvard Technical Report TR-08-10 (2010).

III. The Commission Should Initially Consider Dynamic Access to Underutilized Bands Close in Frequency to Existing Unlicensed Allocations

In a study filed in this docket, Dirk Grunwald, a professor at the University of Colorado at Boulder, considers which particular bands of underutilized spectrum could foster the greatest innovation and usage in a nascent market for DSA devices and services. He observes that because "networks that use unlicensed spectrum are most likely to adopt novel spectrum management techniques . . . the easiest transition would be to identify underutilized spectrum bands that abut current unlicensed allocations."[21] Microsoft, which sponsored Professor Grunwald's research, concurs in its comments that "[f]ocusing first on unlicensed device access makes sense given that unlicensed bands have a proven track record of supporting innovation. Technological and business innovations first developed in the unlicensed context have translated to broad consumer benefits."[22]

Microsoft cites some of the many proven and quantifiable benefits of innovation on unlicensed spectrum – including tens of billions of dollars in economic activity, data traffic off-loading from cellular networks by AT&T and other carriers, and more cost-effective rural broadband by WISPs.[23] Microsoft also notes that the number of unlicensed devices sold, as well as the number of hybrid licensed/unlicensed devices, is projected to dwarf the number of devices relying only on licensed spectrum within just a few years.[24] Similarly, Key Bridge Global LLC notes "that the number and variety of radio devices operating in the unlicensed ISM bands (especially at 2.4 GHz) exceed the number of devices certified to operate in other bands by

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[21] Comments of Dirk Grunwald, Attachment: "How New Technologies Can Turn a Spectrum Crisis into a Spectrum Opportunity," at 31 (Feb. 2011), available at http://systems.cs.colorado.edu/mediawiki/index.php/User:Grunwald.
[22] Comments of Microsoft at 8.
[23] *Id.* at 2-4; *see also* Comments of WISPA at 1 ("WISPs serve more than two million residential and business customers and operate in every state.").
[24] Comments of Microsoft at 3.

almost three times."[25] PISC previously showed in greater detail a similar trend in device innovation, in generated economic activity, and in the off-loading of data onto WiFi local area networks from carrier networks, in its comments filed in response to the Wireless Innovation Notice of Inquiry, which comments it incorporates here by reference.[26]

While PISC has not been able to conduct its own independent engineering study of the bands recommended by Professor Grunwald, we agree with Microsoft that unused or underutilized spectrum close in frequency to existing unlicensed allocations – especially bands with favorable propagation characteristics that are complementary to commercial 4G networks – make sense as an initial focus for a determination of what access conditions and techniques would enable unlicensed or hybrid licensed/unlicensed networks to incorporate that unused capacity. Professor Grunwald offers the following bands as examples of spectrum that by this logic are good candidates to be considered for DSA band sharing:[27]

- The 420-450 band currently used for government and private land mobile radio services, amateur, and certain federal applications;
- In addition to TVWS spectrum under the current TV band plan (*i.e.*, portions of 54-72, 76-88, 174-216, 470-512, 512-608 MHz), contiguous spectrum arising from any repacking of existing TV channels;
- Portions of the 960-1215 MHz radio navigation and amateur bands because of their proximity to the 900 MHz Industrial, Science, and Manufacturing (ISM) band and to TVWS;
- Controlled use of the 2360-2400 and the 2500-2655 MHz bands because of proximity to the existing 2400 MHz ISM band; and
- Controlled use of the 2900-3100 MHz and the 3550-3650 MHz band because of proximity to the "lightly licensed" 3650-3700 MHz band.

[25] Comments of Key Bridge Global LLC at 2-3 (filed Feb. 1, 2011).
[26] *See, e.g.*, Reply Comments of the Public Interest Spectrum Coalition, GN Docket Nos. 09-157, 09-51, at 3, 15, 40 (Nov. 5, 2009).
[27] Comments of Dirk Grunwald, Attachment, at 31-32; Comments of Microsoft at 9.

IV. Dynamic Access to Unused or Underutilized Spectrum Would Not Diminish the Value of Intensively Utilized Exclusively Licensed Commercial Bands

Perhaps unsurprisingly, a number of commenters exhort the potential spectrum efficiency associated with their own use of cognitive and dynamic spectrum technologies,[28] yet focus their comments on why it would be infeasible, inappropriate, and inefficient to permit third parties to use these technologies in order to share unused capacity on these commenters' own licensed spectrum. The Satellite Industry Association, CTIA, APCO, and the Telecommunications Industry Association are among the parties that emphasize why they believe that involuntary and/or uncoordinated access to unused spectrum capacity in bands licensed by their members would be counterproductive.[29]

PISC notes that the most lengthy and forceful comments expressing opposition to "involuntary" band sharing come from the commercial mobile wireless carriers that are generally considered to use their deployed spectrum intensively and to be in need of more spectrum in the near future. Accordingly, Verizon Wireless states "the Commission should not require CMRS licensees to share their spectrum with dynamic spectrum access technology users under any circumstances."[30] CTIA concludes that "the Commission should decline to impose involuntary spectrum easements on commercial mobile spectrum which risk interference and create uncertainty . . . undermining investment, innovation and efficient spectrum use."[31] And AT&T likewise asserts that "the licensed commercial mobile frequencies are inappropriate for deployment of [DSA] technologies outside of the control of the licensee."[32]

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[28] *See, e.g.,* Comments of AT&T at 4; Comments of Verizon Wireless at 8.
[29] *See, e.g.,* Comments of APCO at 2; Comments of CTIA at 11-13; Comments of SIA at 1; Comments of Telecommunications Industry Association at 6.
[30] Comments of Verizon Wireless at 9.
[31] Comments of CTIA at 1.
[32] Comments of AT&T at 6.

PISC finds these very defensive comments by the CMRS licensees to be oddly irrelevant to the stated purpose of the *Notice* and to the constructive proposals made by our organizations, by high-tech companies and innovators, and by spectrum experts and academics. All of these entities submitting relevant comments in this docket suggest that the Commission explore expanding on the technologies and governance techniques in the new TV white spaces rules, doing so in order to open other unused or underutilized spectrum for at least temporary use in a manner that does not detract from any assigned license rights or incumbent operations. In its initial comments, PISC "reiterate[d] its contention that frequency bands that are intensively and efficiently in use – such as the bands used for CMRS – are the least suitable candidates for spectrum band sharing, except possibly in geographic areas that are not built out."[33] Similarly, Microsoft's comments identify many particular bands for potential shared use, but also state that "because Commercial Mobile Radio Service (CMRS) providers intensively use their spectrum, mandated access by smart radios would not be appropriate in spectrum bands licensed for their exclusive use."[34] PISC's comments went on to state "that permitting opportunistic access to unused or underutilized spectrum ultimately must occur on a band-by-band basis," and noted:

> There are many hundreds of MHz of high-quality spectrum in other bands, far more lightly used and better suited to opportunistic access, than are the PCS and other bands used by the commercial wireless industry.
>
> The most obvious category, as recommended in the National Broadband Plan, is FCC-held spectrum. Another immediate focus for this effort, in collaboration with NTIA, should be the identification and analysis of federal bands that NTIA has determined cannot be cleared for reallocation by auction, but which could, under stringent conditions (*e.g.*, exclusion zones, power limits) be opened for shared access by the private sector. A third category that the Commission should address in a future NPRM is "white space" on licensed bands that have not been built out in substantial portions of the country. . . .[35]

[33] PISC Comments at 28.
[34] Comments of Microsoft at 2.
[35] PISC Comments at 28-29.

While PISC agrees that CMRS bands generally are among the most intensively and efficiently used – and generate enormous economic and social value – it is also important to make a distinction between licensed spectrum that is being used to serve the public interest and licensed spectrum that lies fallow. AT&T expends great effort in its comments to distinguish the TV white spaces from the CMRS bands. The company argues that unlike the more static and less populated broadcast TV channels, the CMRS bands are occupied by "over 250,000 mobile cell sites . . . and more than 292 million mobile subscriber connections."[36]

While that is true enough, AT&T neglects to mention a more relevant difference with respect to dynamic spectrum access, which is that the TV bands geolocation database is designed to identify and permit unlicensed devices to operate only on channels that are *not occupied by licensed operations* and in discrete geographical locations that *avoid co-channel operation* with a licensed broadcast or wireless microphone operator. None of the categories of unused or grossly underutilized spectrum identified by PISC or other commenters in this docket as potential candidates for dynamic spectrum sharing includes the frequencies or locations where commercial wireless operators such as AT&T and Verizon Wireless are actually operating. Indeed, as noted above, later in its comments AT&T acknowledges that cognitive radio technologies at least "have the potential to make more efficient use of underutilized Federal spectrum bands in the areas and at the times when Federal users are not occupying them."[37] Thus, AT&T's attempt to create a straw man of the concept of dynamic spectrum sharing is at best orthogonal to the purposes of the *Notice*. Instead of defending intensively utilized spectrum from imagined threats, the Commission should proceed with its constructive regulatory inquiry into how band-

[36] Comments of AT&T at 12.
[37] *Id.* at 18; *see also* Comments of Verizon Wireless at 19 ("Dynamic spectrum access technologies could make the rest of the spectrum in these [underutilized] bands available for alternative uses, including commercial wireless services.").

sharing can help the nation meet the goal, initially articulated by Chairman Genachowski and in the National Broadband Plan, of opening an additional 500 MHz of high-quality spectrum over the next five to ten years.

CONCLUSION

PISC fully supports the Commission's efforts, initiated with this NOI, to adopt policies that enable emerging dynamic spectrum access technologies and governance mechanisms, such as the TV white spaces database, to unlock the nation's "vast wasteland" of unused and underutilized spectrum capacity. As consumer demand for mobile data begins to outstrip network capacity, the nation will soon run out of high-quality spectrum that can be reallocated for mobile broadband services on an exclusively licensed basis. It is critical that the Commission get ahead of this trend and lay the groundwork to harness DSA technologies to enable more band sharing and opportunistic access to unused capacity on both a licensed and unlicensed basis.

Respectfully Submitted,

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